



The 14th International Multi-Conference on Complexity, Informatics and Cybernetics

March 28 - 31, 2023 – Virtual Conference

PROCEEDINGS

Edited by:

Nagib Callaos
Shigehiro Hashimoto
Natalja Lace
Belkis Sánchez
Michael Savoie



Organized by

International Institute of Informatics and Systemics

Member of the International Federation for Systems Research (IFSR)

COPYRIGHT

Copyright and Reprint Permission: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy for private use. Instructors are permitted to photocopy, for private use, isolated articles for non-commercial classroom use without fee. For other copies, reprint, or republication permission, write to IIS Copyright Manager, 13750 West Colonial Drive, Suite 350 - 408, Winter Garden, Florida 34787, U.S.A.

All rights reserved. Copyright 2023. © by the International Institute of Informatics and Systemics.

The papers of this book comprise the proceedings of the conference mentioned on the title and the cover page. They reflect the authors' opinions and, with the purpose of timely disseminations, are published as presented and without change. Their inclusion in these proceedings does not necessarily constitute endorsement by the editors.

Published in the U.S. by the International Institute of Informatics and Cybernetics in 2023.

ISSN: 2771-5914

<https://doi.org/10.54808/IMCIC2023.01>

ISBN: 978-1-950492-71-8



14th International Multi-Conference on
Complexity, Informatics and Cybernetics: IMCIC 2023

HONORARY PRESIDENT

William Lesso, USA (1931-2015)

GENERAL CHAIRS

Nagib Callaos, USA

Hsing-Wei Chu, USA

ORGANIZING COMMITTEE CHAIR

Belkis Sánchez, USA

ORGANIZERS OF INVITED SESSIONS

Shigehiro Hashimoto, Japan

Hirotooshi Hishida, Japan

Konstantins Kozlovskis, Latvia

Natalja Lace, Latvia

PROGRAM COMMITTEE

Chairs:

Michael Savoie, USA

José Ferrer, Venezuela

Jeremy Horne, USA/Mexico

Suzanne Kay Lunsford, USA

T. Grandon Gill, USA

Thierry Lefevre, Thailand

Sushil Archarya, USA

Andrés Tremante, USA

Esther Zaretsky, Israel

Abuleil, Saleem

Chicago State University, USA

Ahmad, Imran

Cloudanum Inc., Canada

Alhayyan, Khalid N.

Institute of Public Administration, Saudi Arabia

Alsamara, Khalid

Chicago State University, USA

Aquino Lopes, Renato de

Federal University of Uberlandia, Brazil

Aruga, Masahiro

Tokai University Japan, Japan

Ash, George

Franciscan University, USA

Ayala, Paulina

Universidad Técnica de Ambato, Ecuador

Baracho, Renata Maria Abrantes

Federal University of Minas Gerais, Brazil

Basthikodi, Mustafa

Sahyadri College of Engineering and Management, India

Benedicenti, Luigi

University of Regina, Canada

Bernardino, Jorge

Coimbra Institute of Engineering, Portugal

Bishop, Desmond (Tres)

University of South Florida, USA

Bönke, Dietmar

Reutlingen University, Germany

Bowman, Timothy

Middletown City Schools, USA

Burnett, Andrea

University of the West Indies, Barbados

Cardoso, Alexandre

Federal University of Uberlandia, Brazil

Castellanos, Esteban X.

University of the Armed Forces, Ecuador

Chen, Chau-Kuang

Meharry Medical College, USA

Chen, Jing-Chao

Donghua University, China

Chen, Lisa Y.

I-Shou University, Taiwan

Chen, Zhebo

Taizhou Institute of Zhejiang University, China

Correa, Luiza Giori Barcellos

Federal University of Minas Gerais, Brazil

Curran, Kevin

University of Ulster, United Kingdom

De Abreu, Joao Francisco

Catholic University of Minas Gerais, Brazil

Demestichas, Konstantinos

National Technical University of Athens, Greece

Dittes, Frank-Michael

University of Applied Sciences Nordhausen, Germany

Eshragh, Sepideh

University of Delaware, USA

Fabiano, Nicola

Studio Legale Fabiano, Italy

Foltz, Kevin

Institute for Defense Analyses, USA

Gradinaru, Alexandru

University Politehnica Bucharest, Romania

Haba, Cristian-Gyözö

"Gheorghe Asachi" Technical University of Iași, Romania

Hargas, Libor

University of Zilina, Slovakia

Horne, Jeremy

Inventors Assistance League, USA

Hughes Jr., John
Meharry Medical College, USA

Iembo, Rosanna
University of Calabria, Italy

Irwin, Bill
Huron University College, Canada

Kachanova, Tamara L.
Saint-Petersburg State Electrotechnical University "LETI", Russian Federation

Kamper, Derek
Illinois Institute of Technology, USA

Kim, Kyungdeok
Uiduk University, South Korea

Kim, Seulbae
Korea University, South Korea

Koch, Gerda
AIT Forschungsgesellschaft mbH, Austria

Koch, Walter
Steinbeis Transferzentrum IMCHI, Austria

Kokiko, Charles M.
Jefferson County Educational Service Center, USA

Koleva, Maria
Bulgarian Academy of Sciences, Bulgaria

Koniar, Dusan
University of Zilina, Slovakia

Kusumi, Ariyoshi
Chukyo University, Japan

Kwon, Hyuckmin
Korea University, South Korea

La Manna, Mario
Evoelectronics, Italy

Lewis, Nora
Wright State University, USA

Li, Xiaoxia
Zhejiang University, China

Lokaj, Zdenek
Czech Technical University in Prague, Czech Republic

Lopes, Ederaldo J.
Federal University of Uberlandia, Brazil

López Román, Leobardo
University of Sonora, Mexico

Lunsford, Suzanne K.
Wright State University, USA

Malhotra, Rashmi
Saint Joseph's University, USA

Marino, Mark
Erie County Community College, USA

Marlowe, Thomas
Seton Hall University, USA

Martin, Marcienne
Laboratoire ORACLE, France

Mascari, Jean-François
National Research Council Italy, Italy

Masuko, Mayumi
Waseda University, Japan

Mbobi, Aime Mokhoo
Centennial College, Canada

Naah, Basil
Wright State University, USA

Ophir, Dan
Ariel University Center of Samaria, Israel

Orantes-Jiménez, Sandra D.
Instituto Politécnico Nacional, Mexico

Oropeza, Miguel A.
University of Aguascalientes, Mexico

Pickl, Stefan
Bundeswehr University Munich, Germany

Poobrasert, Onintra
National Electronics and Computer Technology Center, Thailand

Porto, Marcelo
Federal University of Minas Gerais, Brazil

Preuss, Fabian
University of Wisconsin Parkside, USA

Rodríguez, Jorge E.
Francisco José de Caldas District University, Colombia

Roslovtssev, Vladimir
National Research Nuclear University MEPhI, Russian Federation

Sala, Nicoletta
University of Italian Switzerland Largo Bernasconi, Switzerland

Samuels, A. Dexter
Meharry Medical College, USA

Schuh, Günther
RWTH Aachen University, Germany

Shin, Jungpil
University of Aizu, Japan

Simonova, Anna
University of Zilina, Slovakia

Simpson, William R.
Institute for Defense Analyses, USA

Smit, Peter
Crisis Support Team, Netherlands

Soceanu, Alexandru
Munich University of Applied Sciences, Germany

Spanikova, Gabriela
Comenius University in Bratislava, Slovakia

Stasytyte, Viktorija
Vilnius Gediminas Technical University, Lithuania

Stringer, Joseph
Middletown City Schools Middletown, USA

Sun, Baolin
Wuhan University, China

Tchier, Fairouz
King Saud University, USA

Tolias, Stamatina
Wright State University, USA

Vasinek, Vladimir
Technical University of Ostrava, Czech Republic

Vasylenko, Maksym
Munich University of Applied Sciences, Germany

Vivanco, Jesús Salvador
University of Aguascalientes, Mexico

Vogt, Klaus
Medical Practice Schachenreiter, Latvia

Vrána, Stanislav
Czech Technical University in Prague, Czech Republic

Wang, Jixue
China Renewable Energy Engineering Institute, China

Waters, David J.
Purdue University, USA

Yan, Wenjun
Zhejiang University, China

Yang, Qiang
Zhejiang University-Taihu University, China

Zelinka, Tomas
Czech Technical University in Prague, Czech Republic

Zhang, Xiaozheng Jane
California Polytechnic State University, USA

Zykov, Sergey
National Research University Higher School of Economics,
Russian Federation

ADDITIONAL REVIEWERS WHO MADE AT LEAST ONE DOUBLE-BLIND REVIEW

Acharya, Sushil
Robert Morris University, USA

Amos, David
University of Lorraine, France

Aqqal, Abdelhak
Chouaib Doukkali University, Morocco

Armitage, William D.
University of South Florida, USA

Atan, Mohd Farid
Universiti Malaysia Sarawak, Malaysia

Aveledo, Marianella
Universidad Simon Bolivar, Spain

Aziz, Soulhi
Ecole Nationale Supérieure des Mines de Rabat, Morocco

Bocu, Razvan
University College Cork, Ireland

Bolboacă, Sorana D.
Iuliu Hațieganu University of Medicine and Pharmacy, Romania

Bubnov, Alexey
Czech Academy of Sciences, Czech Republic

Caldararu, Florin
Research Laboratory for Environmental Monitoring and
Semiconductor Sensors, Romania

Caridade, Cristina
Coimbra Institute of Engineering, Portugal

Carrasquero, José Vicente
Simon Bolivar University, Venezuela

Chaikla, Nidapan
Freelance, Thailand

Chen, Jingchao
DongHua University, China

Contreras, Leonardo
Simon Bolivar University, Venezuela

Crippa, Paolo
Marche Polytechnic University, Italy

Crudele, Michele
Istituto per Ricerche ed Attività Educative, Italy

Dai, Weizhong
Louisiana Tech University, USA

Djeffal, Lakhdar
University of Batna 2, Algeria

Druzovec, Marjan
University of Maribor, Slovenia

Dugarte Peña, Germán Lenin
Universidad Francisco de Vitoria, Spain

Dvornik, Josko
University of Split, Croatia

Eloiza, Oliveira
Universidade do Estado do Rio de Janeiro, Brazil

Farhaoui, Yousef
Moulay Ismail University, Morocco

Farooq, Omar
Aligarh Muslim University, India

Félez, Jesús
Polytechnic University of Madrid, Spain

Figueiredo, Carolina
Federal University of Pernambuco, Brazil

Figueroa de La Cruz, Mario M.
National Technological University, Argentina

Fikret Ercan, M.
Singapore Polytechnic, Singapore

Fox, Richard
Northern Kentucky University, USA

Freire, Fausto
Universidad Tecnológica Equinoccial, Ecuador

Frick, Jan
University of Stavanger, Norway

Gatfaoui, Hayette
IESEG School of Management, France

Gui, M. W.
National Taipei University of Technology, Taiwan

Gundu, Srinivasa Rao
Government Degree College, Sitaphalmandi, India

Ho, Liangwei
Collex Communication Corporation, Taiwan

Hyka, Dolantina
Mediterranean University of Albania, Albania

Ibujés Villacís, Juan
Escuela Politécnica Nacional, Ecuador

Irey, Jorge
University of Lima, Peru

Ishikawa, Hiroshi
Niigata University of International and Information Studies, Japan

Jaïdi, Faouzi
University of Carthage, Tunisia

Janota, Ales
University of Zilina, Slovakia

Jomhari, Nazean
University of Malaya, Malaysia

Khemapech, Ittipong
University of the Thai Chamber of Commerce, Thailand

Kim, Kyungdeok
Uiduk University, South Korea

Kurdi, M. Zakaria
University of Lynchburg, USA

Leu, Fang-Yie
Tunghai University, Taiwan

Leybourne, Bruce
Institute for Advance Studies on Climate Change, USA

Li, Yu-Chiang
Southern Taiwan University of Science and Technolog, Taiwan

Liang, Chih-Chin
National Central University, Taiwan

Lipinski, Piotr
Technical University of Lodz, Poland

Lukman, Iing
Universitas Malahayati, Indonesia

Luo, Jia-Ning
Ming Chuan University, Taiwan

Mainguenaud, Michel
Institut National des Sciences Appliquées, France

Marappan, Raja
SASTRA University, India

Marzuki, Marza Ihsan
Mercu Buana University, Indonesia

Mateen, Ahmed
University of Agriculture Faisalabad, Faisalabad, Pakistan, 38000.,
Pakistan

Melgarejo Heredia, Rafael
Pontificia Universidad Católica del Ecuador, Ecuador

Miraoui, Moeiz
University of Gafsa, Tunisia

Mitra, Pinaki
Indian Institute of Technology Guwahati, India

Mohamed, Gamal Abdel Nassir
Muscat College, Oman

Mohamed Sahari, Khairul Salleh
University Tenaga National, Malaysia

Nagy, Endre
The Society of Instrument and Control Engineers, Japan

Nakache, Didier
Centre for Studies and Research in Computer, France

Narasimhan, Lakshmi
University of Botswana, Botswana

Nayyar, Anand
Duy Tan University, Vietnam

Pavaloiu, Ionel-Bujorel
University Politehnica of Bucharest, Romania

Pavate, Aruna
St Francis Insitute of Technology, India

Pérez, Carlos
Columbia University of Paraguay, Paraguay

Phakamach, Phongsak
Rajamangala University of Technology, Thailand

Pietrucha-urbanik, Katarzyna
Rzeszow University of Technology, Poland

Poobrasert, Onintra
National Electronics and Computer Technology Center, Thailand

R. K., Bharathi
Sri Jayachamarajendra College of Engineering, India

Rachev, Boris
Technical University of Varna, USA

Rajan, Amala V. S.
Higher Colleges of Technology, United Arab Emirates

Ruan, Tongjun
New Mexico Institute of Mining and Technology, USA

Santos, Joaquín
Simon Bolivar University, Venezuela

Sasakura, Mariko
Okayama University, Japan

Satpute, Vishal
Visvesvaraya National Institute of Technology, India

Savva, Andreas
University of Nicosia, Cyprus

Sbihi, Abdelkader
Université de Paris 1, France

Semenist, Ivan
Borys Grinchenko Kyiv University, Ukraine

Shang, Yilun
Northumbria University, China

Shiraishi, Masatake
Ibaraki University, Japan

Shirkhodaie, Amir
Tennessee State University, USA

Sirkemaa, Seppo
Turku School of Economics and Business Administration, Finland

Stojanov, Stanimir
University of Plovdiv, Bulgaria

Stoleru, Neculai-Daniel
Aereal Bank, Germany

Strefezza, Miguel
Simon Bolivar University, Venezuela

Stvan, Laurel
University of Texas Arlington, USA

Tadepalli, Gopal
Anna University, Chennai, India

Taghouti, Hichem
University of Tunis Elmanar II, Tunisia

Tam, Wing K.
Swinburne University of Technology, Australia

Teixeira Pinto, Leonel
Federal University of Santa Catarina, Brazil

Thurasamy, Ramayah
Science University of Malaysia, Malaysia

Trinca Watanabe, Cibele Cristina
Federal University of Tocantins, Brazil

Tsiligaridis, John
Heritage University, USA

Vasilache, Simona
University of Tsukuba, Japan

Venco, Elisabetta Maria
University of Pavia, Italy

Verber, Domen
University of Maribor, Solomon Islands

Whitby, Seta
University of La Verne, USA

Wielki, Janusz
Technical University of Opole, Poland

Winckler, Michael
Heidelberg University, Germany

Zyubin, Vladimir
Institute of Automation and Electrometry, Russian Federation

ADDITIONAL REVIEWERS WHO MADE AT LEAST ONE NON-BLIND REVIEW

Abu El-Sebah, Mohamed
Electronics Research Institute, Egypt

Alain, Stockless
Université du Québec à Montréal, Canada

Alalwany, Easa
Florida Atlantic University, USA

Alenezi, Marim
Prince Mohammad Bin Fahd University, Saudi Arabia

Alotaibi, Yazeed
Florida Atlantic University, USA

Alqahtani, Abdulkarim
Florida Atlantic University, USA

Alrefaei, Ahmed
Florida Atlantic University, USA

Antony, Bryce
Auckland University of Technology, New Zealand

Betak, John F.
Collaborative Solutions LLC, USA

Cardinale Villalobos, Leonardo
Instituto Tecnológico de Costa Rica, Costa Rica

Chunga Zapata, Elmer Alfredo
César Vallejo University, Peru

Clapp, Sherry
Center for Advanced Technical Studies, USA

Croll, Christian
KIS Group, France

Cusack, Brian
Auckland University of Technology, New Zealand

Dione, Doudou
Cheikh Anta Diop University, Senegal

Dobrowolska, Malgorzata
Silesian University of Technology, Poland

Erkal, Cahit
University of Tennessee at Martin, USA

Gallos, Lazaros
DIMACS at Rutgers University, USA

Godasu, Rajesh
Dakota State University, USA

Godsall, Lyndon
Miami Dade College, USA

Gueorguieva, Natacha
City University of New York, USA

Gutierrez, Jairo
Auckland University of Technology, New Zealand

Heretakis, Lefteris
Buckinghamshire New University, United Kingdom

Katchen, Johanna
National Tsing Hua University, Taiwan

Khomonenko, Anatoly
Emperor Alexander I St. Petersburg State Transport University,
Russian Federation

Kuzminsky, Alan
Vascular Simulations, USA

Lauzon, Peter
Center for Advanced Technical Studies, USA

Lazebna, Natalia
University of Wuerzburg, Germany

Leduc, Diane
Université du Québec à Montréal, Canada

Liang, Yu
University of Tennessee at Chattanooga, USA

Martynyuk, Tatyana
Georgia Tech, USA

McWright, Mac
Nova Southeastern University, USA

Minkara, Mona
Northeastern University, USA

Oliveira, Rita
Universidade de Aveiro, Portugal

Pepino, Alessandro
University of Naples Federico II, Italy

Prihodko, Ganna
Zaporizhzhya National University, Ukraine

Qin, Hong
University of Tennessee at Chattanooga, USA

Quesada-López, Christian
Universidad de Costa Rica, Costa Rica

Quito Rodríguez, Carmen Zulema
National University of Piura, Peru

Salomon, Jean
JSalomon Consulting Partners, France

Sánchez Trujillo, María De Los Ángeles
Universidad San Ignacio de Loyola, Peru

Sutrave, Kruttika
Dakota State University, USA

Tkacz, Piotr
Wyższa Szkoła Planowania Strategicznego w Dąbrowie Górniczej,
Poland

Tupakhina, Olena
Zaporizhzhya National University, Ukraine

Vorobiev, Evgenii
Saint Petersburg Electrotechnical University "LETI", Russian
Federation

Wu, Dalei
University of Tennessee at Chattanooga, USA

Zafer, Aliah
Prince Mohammad Bin Fahd University, Saudi Arabia

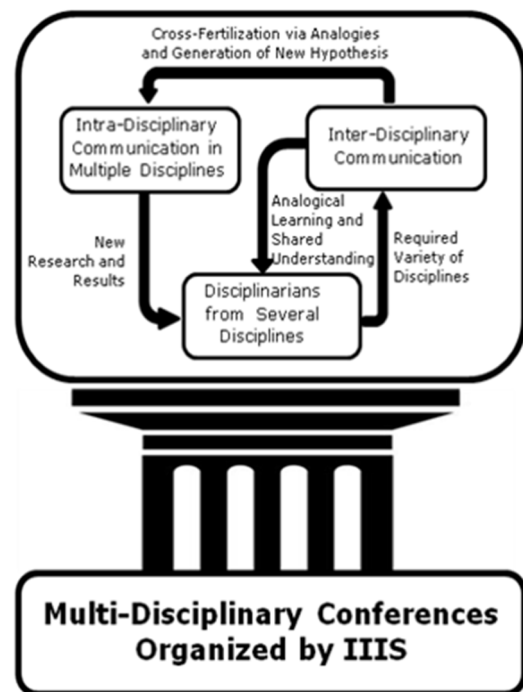
Zatt Schardosin, Fernando
Universidade Federal da Fronteira Sul, Brazil

FOREWORD

Our purpose in organizing the 14th International Multi-Conference on Complexity, Informatics and Cybernetics (IMCIC 2023) jointly with the 14th International Conference on Society and Information Technologies (ICSIT 2023) and their collocated events, including the 13th Ibero-American Conference on Complexity, Informatics and Cybernetics (CICIC 2023), is to provide a multi-disciplinary forum for both disciplinary and inter-disciplinary communication.

These collocated events were organized and sponsored by the International Institute of Informatics and Systemics (IIIS, www.iiis.org), member of the International Federation for Systems Research (IFSR, www.ifsr.org). The IIIS is a **multi-disciplinary organization for inter-disciplinary communication and integration**, which includes about 5000 members. Consequently, a main purpose of the IIIS is to foster knowledge integration processes, interdisciplinary communication, and integration of academic activities. Based on: 1) the transdisciplinarity of the systemic approach and its emphasis on *relationships* and *integrating* processes, and 2) the multi-disciplinary support of cybernetics' and informatics' concepts, notions, theories, technologies, and tools, the IIIS has been organizing multi-disciplinary conferences as a platform for fostering inter-disciplinary communication and knowledge integration processes.

Multi-disciplinary conferences are organized by the IIIS as support for both **intra-** and **inter-disciplinary** communication. Processes of intra-disciplinary communication are mainly achieved via traditional paper presentations in corresponding disciplines, while conversational sessions, regarding trans- and inter-disciplinary topics, are among the means used for inter-disciplinary communication. Intra- and inter-disciplinary communications might generate *co-regulative cybernetic loops*, via negative feedback, and *synergic* relationships, via positive feedback loops, in which both kinds of communications could increase their respective effectiveness. Figure (at the right side) shows at least two cybernetic loops if intra- and inter-disciplinary are adequately related. A necessary condition for the effectiveness of Inter-disciplinary communication is an adequate level of **variety** regarding the participating disciplines. *Analogical thinking and learning processes* of disciplinarians depend on it; which in turn are potential sources of the creative tension required for cross-fertilization among disciplines and the generations of new hypothesis. An extended presentation regarding this issue can be found at <http://www.iiis.org/MainPurpose/>



In general, IIIS is an organization dedicated to contributing to the development of the Systems Approach, Cybernetics, and Informatics potential, using both: knowledge and experience, thinking and action, for the:

- identification of synergetic relationships among Systemics, Cybernetics and Informatics, and between them and society;
- promotion of contacts among the different academic areas, through the transdisciplinarity of the systems approach;

- c. identification and implementation of communication channels among the different professions;
- d. supply of communication links between the academic and professional worlds, as well as between them and the business world, both public and private, political and cultural;
- e. stimulus for the creation of integrative arrangements at different levels of society, as well as at the family and personal levels;
- f. promotion of transdisciplinary research, both on theoretical issues and on applications to concrete problems.

Our objective organizing the 14th International Multi-Conference on Complexity, Informatics and Cybernetics (IMCIC 2023) is to provide, in these increasingly related areas, a multi-disciplinary forum, to foster interdisciplinary communication among the participants, and to support the sharing process of diverse perspectives of the same transdisciplinary concepts and principles. Complexity, Cybernetics and Informatics are being increasingly related to each other in almost every scientific discipline, engineering area, and human activity. Their common transdisciplinarity characterizes and communicates them, generating strong relations among them and with other disciplines. They work together to create a whole new way of thinking and practice. This phenomenon persuaded the Organizing Committee to structure IMCIC 2023 as a multi-conference where participants may focus on one area, or on one discipline, while allowing them the possibility of attending events from other areas or disciplines. This systemic approach stimulates cross-fertilization among different disciplines, inspiring scholars, originating new hypothesis, supporting production of innovations and generating analogies; which is, after all, one of the very basic principles of the systems' movement and a fundamental aim in cybernetics.

One of the main objectives of the 14th International Conference on Society and Information Technologies (ICSIT 2023) and the 14th International Conference on Education, Training and Informatics (ICETI 2023) is to bring together academics, professionals, and managers from the private and the public sectors, so they can share ideas, results of research, and innovative services or products, in a multi-disciplinary and multi-sector forum.

Educational technologies, socio-economic organizations, and socio-political processes are essential domains among those involved in the evolving co-adaptation and co-transformation between societies and cultures on the one hand, and between informatics and cybernetics (communication and control) on the other hand.

ICSIT 2023 and ICETI 2023 are related to each other, as well as to IMCIC 2023 and, as a whole, are producing or might produce synergic relationships with Information and Communication Technologies. This is why the Organizing Committees have the purpose of combining their efforts in a way that would lead to the organization of an adequate joint event, where academics, researchers, consultants, professionals, innovators, and practitioners from the three areas might relate and interact with each other in the same event. These types of interaction might generate possibilities of cross-fertilization and analogical thinking, as well as possibilities of new working hypothesis, ideas, and reflections on the impact, significance, and usefulness of Informatics and Cybernetics in important dimensions of educational, socio-political, and socio-economical processes, services, and products.

On behalf of the Organizing Committee, I extend our heartfelt thanks to the Program Committees' members, to the 376 reviewers, from 65 countries, who made the **double-blinded** reviews, and to the 154 reviewers, from 35 countries, who made the **non-blind** reviews. (Some reviewers supported both: non-blind and double-blind reviewing for different submissions). A total of 1041 reviews made by 530 reviewers (who made at least one review), from 71 countries contributed to the quality achieved in IMCIC/ICETI/CICIC 2023. This means an average of **6.02 reviews per submission** (173 submissions were received). Each registered author had access, via the conference web site, to the reviews that recommended the acceptance of their respective submissions. Each registered author could get information about: 1) the average of the reviewers' evaluations according to 8 criteria, and the average of a global evaluation of his/her submission; and 2) the comments and

the constructive feedback made by the reviewers, who recommended the acceptance of his/her submission, so the author would be able to improve the final version of the paper.

In the organizational process of IMCIC/ICSIT 2023, about 104 articles were submitted. The IMCIC/ICSIT 2023 proceedings include about 62 papers from 23 countries (41 papers from IMCIC and 21 papers from ICSIT), which were accepted for presentation. *The submissions were reviewed as carefully as time permitted; it is expected that most of them will appear in a more polished and complete form in scientific journals. As announced in the conference web site authors of the respective papers “are responsible of the content of their respective papers, as well as for their respective proofreading and copyediting.”*

This information is detailed and totaled in the following table, along with the other collocated event:

Conference	# of submissions received	# of reviewers that made at least one review	# of reviews made	Average of reviews per reviewer	Average of reviews per submission	# of papers included in the proceedings	% of submissions included in the proceedings
IMCIC 2023	60	171	283	1.65	4.72	41	68.33 %
ICSIT 2023	44	149	260	1.74	5.91	21	47.73 %
CICIC 2023	69	210	498	2.37	7.22	46	66.67 %
TOTAL 2023	173	530	1041	1.96	6.02	108	62.43 %

We also extend our gratitude to the co-editors of these proceedings, for the hard work, energy and eagerness they displayed in their respective activities. We express our intense gratitude to the late Professor William Lesso for his wise and opportune tutoring, for his eternal energy, integrity, and continuous support and advice, as the Program Committee Chair of past conferences, organized by the International Institute of Informatics and Systemics, as well as for being a very caring old friend and intellectual father to many of us.

Special thanks to Professors José Ferrer and Michael Savoie for co-chairing IMCIC 2023 Program Committee, to Professor Hsing-Wei Chu for his General Co-chairmanship, and to Belkis Sánchez for chairing its Organizing Committee. Special thanks also to Professor Friedrich Welsch for chairing ICETI 2023, Professors José Ferrer and Belkis Sánchez for co-chairing its Organizing Committee, and to Professor Andrés Tremante for serving as General Co-chair.

We also extend our gratitude to the following scholars, researchers, and professionals who (up to the moment in which this Foreword is being written) accepted to deliver plenary Workshop and Tutorial, support the conference as panelists in conversational panels, chair conversational sessions and/or to address the audience of the General Joint Plenary Sessions with keynote addresses (More details, abstracts and short bios, were included in the Conference Program booklet and at: <http://www.iiis.org/spring2023plenaryevents>)

Plenary Keynote Speakers (ordered by last name)

- **Dr. Risa Blair**, Purdue University Global, USA.
- **Dr. Areej ElSary**, Zayed University, United Arab Emirates.
- **Professor Shigehiro Hashimoto**, Kogakuin University, Japan.
- **Professor Mohammad Ilyas**, Florida Atlantic University, USA.
- **Professor Anastassis Kozanitis**, University of Quebec in Montreal, Canada.
- **Dr. Masaaki Kunigami**, Tokyo Institute of Technology, Japan.
- **Dr. Fr. Joseph R. Laracy**, Seton Hall University, USA.
- **Professor Rusudan Makhachashvili**, Borys Grinchenko Kyiv University, Ukraine.

- **Professor Thomas Marlowe**, Seton Hall University, USA.
- **Professor Chieko Nakabasami**, Toyo University, Japan.
- **Dr. Paweł Poszytek**, Foundation for the Development of the Education System, Poland.
- **Professor Kuldeep Rawat**, Elizabeth City State University, USA.
- **Dr. Lorayne Robertson**, Ontario Tech University, Canada.
- **Dr. Erin Ryan**, Kennesaw State University, USA.
- **Professor Ivan Semenist**, Borys Grinchenko Kyiv University, Ukraine.
- **Gerard Ward**, PhD Candidate at The University of Auckland, New Zealand.

We also would like to extend our appreciation and express our thankfulness and gratitude to the following invited session organizers, for their time and for getting in charge of the reviewing processes of their respective invited sessions.

Invited Sessions Organizers and Co-Organizers (ordered by last name)

- **Professor Shigehiro Hashimoto**, Kogakuin University, Japan.
- **Professor Hirotooshi Hishida**, Kogakuin University, Japan.
- **Dr. Konstantins Kozlovskis**, Riga Technical University, Latvia.
- **Professor Natalja Lāce**, Riga Technical University, Latvia.
- **Dr. William Muirhead**, Ontario Tech University, Canada.
- **Dr. Lorayne Robertson**, Ontario Tech University, Canada.
- **Dr. Elena Fabiola Ruiz Ledesma**, Instituto Politécnico Nacional, México.
- **Professor Trung Tran**, Vietnam Academy for Ethnic Minorities, Vietnam.

We also wish to thank all the authors for the quality of their papers, and to the 530 reviewers (who reviewed at least one article of IMCIC/ICSIT/CICIC 2023 and its collocated events) for the great job they did, making the 1041 reviews that supported the acceptance process. We also extend our gratitude to all the members of the secretariat and the staff for their knowledgeable effort in supporting the organizational process, the help desk, and the production of the proceedings.

Professor Nagib C. Callaos
IMCIC 2023 General Co-Chair

TABLE OF CONTENTS

Table of Contents

i

Biomedical Engineering - Invited Session

Organizers: Shigehiro Hashimoto and Hirotoishi Hishida (Japan)

Endo, Yoshiaki; Hashimoto, Shigehiro (Japan): "Measurement of Repetitive Contractile Movement of Myotubes by Markers on Scaffold Film"	1
Hashimoto, Shigehiro; Kishimoto, Kazuya (Japan): "Effect of Force Field Direction on Elongation of Myoblast"	7
Hashimoto, Shigehiro; Uehara, Shogo; Kurihara, Ayaka (Japan): "Deformation Direction of Cells Related to Passing Velocity Through Microgap"	12
Moriizumi, Natsuki; Hashimoto, Shigehiro; Uehara, Shogo (Japan): "Movement of Cell Flowing Over Oblique Microgroove"	17
Ono, Ryuya; Hashimoto, Shigehiro; Minato, Takuma (Japan): "Effect of Cell Velocity on Dielectrophoretic Movement in Microchannel"	23
Yonezawa, Hiroki; Hashimoto, Shigehiro; Ono, Ryuya (Japan): "Effect of Wall Shear Stress on Myoblast Orientation Distribution"	29

Case Studies and Methodologies

Mele, Michele; Sicignano, Gennaro (Italy): "The Analogical Way: How Blind People Used to Do Mathematics Before the Computer Era"	35
More Valencia, Rubén Alexander; Puicon Zapata, Hoover Augusto; Cruz Vilchez, Francisco Javier; Requena Flores, Rigo Felix; Agurto Marchán, Winner (Peru): "Change Management and Enterprise Resource Planning (ERP) for Cloud Computing (CC) Services Based on Business Process Management (BPM): Case of an Oil Exploration Company"	38
Rossi, Rafael Wohleberg; de Rolt, Carlos Roberto; Trevisan, Luis Antonio Pittol (Brazil): "Applicability of the <i>Intelligence-Led Policing</i> Model in Brazil: The Case of the Military State Police of Santa Catarina"	45

Computer Science and Engineering

Alrefaei, Ahmed; Alotaibi, Yazeed; Ilyas, Mohammad (USA): "Detection Techniques on the Internet of Things (IoT): A Survey of Current Challenges and Open Issues"	51
Balhareth, Ghaida; Alsolami, Theyab; Ilyas, Mohammad (USA): "IoT Big Data Privacy Using Blockchain Technology: A Survey"	58
Méndez-Porras, Abel; Alfaro-Velasco, Jorge; Jiménez-Delgado, Efren (Costa Rica): "Defect Inspection and Detection in Solar Panels Using Image Sensing Technology: A Systematic Mapping Study"	64
Nalluri, Nithya; Bsales, Michael; Nelson, Christie (USA): "Data-Driven Security Measurements to Improve Safety in NYC and NJ Mass Transit"	72
Nenov, Hristo; Djambazoff, Phil (Bulgaria): "Efficient Minimization of the Probability of Software Errors Migration Within the SDLC"	79
Tsai, Li-An; Nuckels, Estelle; Wang, Yingfeng (USA): "Integrating Quantum Computing into De Novo Metabolite Identification"	84

Computer Security and Security Technologies

Alsaiari, Abdulhakim; Ilyas, Mohammad (USA): "A Review on Security and Privacy of Smart Cities"	88
Alsolami, Theyab; Balhareth, Ghaida; Ilyas, Mohammad (USA): "Survey for Security in IoT in e-Healthcare"	94
Blair, Risa (USA): "Cloud-Based Services and Recommendations"	98
Carta, Kévin; Huynh, André; Mouille, Stéfane; El Mrabet, Nadia; Barral, Claude; Brangoulo, Sébastien (France): "How Video Injection Attacks Can Even Challenge State-of-the-Art Face Presentation Attack Detection Systems"	105
Ward, Gerard; Janczewski, Lech (New Zealand): "The PISA Model: A Common Data Security Model for the Industrial Internet of Things (IIoT) Information Systems"	113

Control, Communication and Network Systems

Cwiakala, Martin (USA): "A Future Prediction on the Human-Computer Interface"	121
Encarnação, João; Velhinho, Ana; Bentes, Simão; Silva, Telmo; Abreu, Jorge; Santos, Rita (Portugal): "Promoting Trustworthy News Through iTV Notifications"	125
Perez-Perez, David; Gonzalez, Gilberto; Tansel, Ibrahim (USA): "Autonomous Utility Vehicle Development by Using Depth Camera and Machine Learning"	128

ICT Applications in Education

Kozanitis, Anastassis (Canada): "Comparing Real Time Student Situational Engagement in Traditional and Active Learning Classroom Using Non-invasive Electrodermal Measurements" 133

Poszytek, Paweł; Fila, Jadwiga; Jeżowski, Mateusz (Poland): "University-Business Collaboration as a Mean to Enhance the Development of Competences 4.0" 139

Towards Business Sophistication and Sustainability - Invited Session

Organizers: Natalja Lace and Konstantins Kozlovskis (Latvia)

Čirjevskis, Andrejs (Latvia): "Measuring Explicit and Valuing Tacit Synergies of High-Tech Based M&A Deals: From Real Options Perspective" 143

Liu, Yuan Yuan *; Lace, Natalja *; Koleda, Nadezda *; Chen, Lu Lu ** (* Latvia, ** China): "Higher Education Students' Motivations to Choose Bilingual Courses in Tourism Management" 149

Liu, Yuan Yuan *; Lace, Natalja *; Chen, Lu Lu ** (* Latvia, ** China): "METAVERSE for Destination Marketing in the Era of Great Changes" 156

Matisone, Anita; Lace, Natalja (Latvia): "Infrastructure Funding Gap in Baltic States" 162

Zumente, Ilze; Lāce, Natalja (Latvia): "Understanding Corporate Sustainability Drivers Across Corporate Life Cycle" 168

Trans- and Inter-Disciplinary Research, Education, and Communication: TIDREC

Alamri, Hayat; Al-Amri, Aisha (Saudi Arabia): "Arabic-English Machine Translation (MT) Quality: Exploring Researchers' Perspectives and Challenges" 176

Alves-Hopf, Simone *; Moura Vieira, Maria Edna **; Hoefel, Maria da Graça Luderitz *** (* Germany, ** Spain, *** Brazil): "Primary Healthcare Face to the Long COVID-19 Syndrome: Building Comprehensive Care Bridges" 183

Beichter, Tim; Kaiser, Manuel (Germany): "The Future of Upskilling: Human- and Technology-Centered" 190

Geyda, Alexander (Russian Federation): "Pragmatic Measures of Information Quality for Changing Activity Success in Systems" 194

Hoefel, Maria da Graça Luderitz *; Moura-Vieira, Maria Edna **; Alves-Hopf, Simone ***; Freire Filha, Lindomar Guedes *; Guerra, Paula **** (* Brazil, ** Spain, *** Germany, **** Portugal): "Graffiti, Migrant Women, Intersectionality: Artistic Experiences in Portugal" 201

Makhachashvili, Rusudan; Semenist, Ivan (Ukraine): "Meta-Disciplinarity of Digital Education and Communication" 209

Makhachashvili, Rusudan; Semenist, Ivan (Ukraine): "Transdisciplinary Communication in the Meta-Framework of Digital Education"	215
Nakabasami, Chieko; Masuko, Miho (Japan): "Tourism Education on Sustainability Through an International Short Film Festival"	221
Ryan, Erin (USA): "Young Children With Autism Spectrum Disorder Learning Emotion-Recognition From Animated Media Content"	227
Ryan, Erin (USA): "An Interdisciplinary Theoretical Framework to Examine Educational Television and Emotion Recognition in Children With Autism Spectrum Disorder"	234
Invited Paper(s) associated to Plenary Keynote Addresses	
Hashimoto, Shigehiro (Japan): "Cross-Cultural Online Networking Based on Biomedical Engineering to Motivate Transdisciplinary Communication Skills"	242
Authors Index	247



Pages 1-246 are not included in this book preview.

To view the papers, please, click the “Home” button at the top of this page, and then, click the “Papers” link for this volume.

AUTHORS INDEX

Abreu, Jorge	125	Janczewski, Lech	113
Agurto Marchán, Winner	38	Jeżowski, Mateusz	139
Alamri, Hayat	176	Jiménez-Delgado, Efren	64
Al-Amri, Aisha	176	Kaiser, Manuel	190
Alfaro-Velasco, Jorge	64	Kishimoto, Kazuya	7
Alotaibi, Yazeed	51	Koleda, Nadezda	149
Alrefaei, Ahmed	51	Kozanitis, Anastassis	133
Alsaiani, Abdulhakim	88	Kurihara, Ayaka	12
Alsolami, Theyab	58; 94	Lāce, Natalja	168
Alves-Hopf, Simone	183; 201	Lace, Natalja	149; 156; 162
Balhareth, Ghaida	58; 94	Liu, Yuan Yuan	149; 156
Barral, Claude	105	Makhachashvili, Rusudan	209; 215
Beichter, Tim	190	Masuko, Miho	221
Bentes, Simão	125	Matisone, Anita	162
Blair, Risa	98	Mele, Michele	35
Brangoulo, Sébastien	105	Méndez-Porras, Abel	64
Bsales, Michael	72	Minato, Takuma	23
Carta, Kévin	105	More Valencia, Rubén Alexander	38
Chen, Lu Lu	149; 156	Moriizumi, Natsuki	17
Čirjevskis, Andrejs	143	Mouille, Stéfane	105
Cruz Vilchez, Francisco Javier	38	Moura Vieira, Maria Edna	183
Cwiakala, Martin	121	Moura-Vieira, Maria Edna	201
de Rolt, Carlos Roberto	45	Nakabasami, Chieko	221
Djambazoff, Phil	79	Nalluri, Nithya	72
El Mrabet, Nadia	105	Nelson, Christie	72
Encarnação, João	125	Nenov, Hristo	79
Endo, Yoshiaki	1	Nuckels, Estelle	84
Fila, Jadwiga	139	Ono, Ryuya	23; 29
Freire Filha, Lindomar Guedes	201	Perez-Perez, David	128
Geyda, Alexander	194	Poszytek, Paweł	139
Gonzalez, Gilberto	128	Puicon Zapata, Hoover Augusto	38
Guerra, Paula	201	Requena Flores, Rigo Felix	38
Hashimoto, Shigehiro	1; 7; 12; 17; 23; 29; 242	Rossi, Rafael Wohleberg	45
Hoefel, Maria da Graça Luderitz	183; 201	Ryan, Erin	227; 234
Huynh, André	105	Santos, Rita	125
Ilyas, Mohammad	51; 58; 88; 94	Semenist, Ivan	209; 215

Sicignano, Gennaro	35
Silva, Telmo	125
Tansel, Ibrahim	128
Trevisan, Luis Antonio Pittol	45
Tsai, Li-An	84
Uehara, Shogo	12; 17
Velhinho, Ana	125
Wang, Yingfeng	84
Ward, Gerard	113
Yonezawa, Hiroki	29
Zumente, Ilze	168